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Describing the U.S. oil and gas extraction workforce with public data

This article serves as a primer for researchers interested in estimating the size, characteristics, dynamics, and distribution of the oil and gas extraction (OGE) workforce using public data. The OGE workforce changes with shifts in energy markets and technology, and accurate OGE workforce estimates are important for assessing workforce needs, understanding injury and illness patterns, and measuring impacts of energy production on local economies. This article provides contextual information about the industry’s structure, establishment types, and corresponding federal classification codes and presents descriptive workforce statistics from several sources, with emphasis on the differences between lead employers, who coordinate production, and specialized employers, who support and contract with the lead employers. Finally, this article also discusses the relationships between industry employer and workforce characteristics and observed variation in injury and illness rates.

Jobs in the U.S. oil and gas extraction (OGE) industry can be created or eliminated quickly when fossil fuel markets change, motivating labor market research specific to OGE companies, occupations, and regions.¹ Definitions of the OGE workforce have varied, due in part to the complexities of the industry and the classification systems that code its establishments, companies, and workers.² This article is intended to serve as a primer for researchers interested in describing the OGE workforce using public data sources and calls attention to three key dimensions: the organization and classification of the industry and its subsectors, the volatility of OGE markets, and the geographic distribution of OGE production and job sites. The article also serves as a case study for researchers interested in characterizing worker populations in other industries using the same federal data sources. Workforce characteristics and their relationships to industrial structure and dynamics help to explain workforce health and safety patterns, and examples are provided to illustrate. The article concludes by describing possible areas of future labor market research to enhance understanding of the OGE workforce.

What is the oil and gas extraction industry?

This section qualitatively describes the ways in which the industry is organized. The following list provides a high-level overview of the oil and gas industry’s main segments, acknowledging that the reality is more complex:

1. Upstream: extraction

a. Onshore

i. Natural gas

ii. Crude oil

b. Offshore

i. Natural gas

ii. Crude oil
2. Midstream: transportation and storage

a. Trucks

b. Pipelines
3. Downstream: preparation and distribution

a. Refining

b. Marketing

c. Selling

The broader oil and gas industry provides services within the upstream, midstream, or downstream segments. The upstream segment—the focus of this article and referred to here forward as the oil and gas extraction (OGE) industry—involves all work activities that occur prior to the moment crude oil or natural gas leaves the earth and passes through a specialized device (a Christmas tree or a choke) to be distributed away from the well for storage, processing, refining, marketing, selling, and use. OGE activity either occurs offshore, such as on engineered ocean platforms, or onshore, such as on specially

built well pads in predominately rural areas throughout the United States. The other segments of the oil and gas industry (midstream, downstream) are outside the scope of this article.

It is possible for a single company or establishment to perform most or all activities required to transform an undeveloped area of land into land that produces oil or natural gas. The workers who perform OGE activities are most often employed by companies that either contract directly with companies in possession of oil and gas leases or with intermediary companies who contract with a leaseholder.

Many OGE worksites have workers employed by multiple companies. The two basic types of companies—common among fissured workplaces—are as follows:³

- **Specialized companies focus on narrowly defined core competencies.** In OGE, companies can become highly specialized in specific activities or processes required for development to occur. Drilling companies are one example, and they compete with other drilling companies for contracts based on their specialized expertise in drilling wells. But drilling companies typically do not have the equipment, expertise, or worker training to perform hydraulic fracturing. That process is performed by other specialized companies that are generally classed with various “servicing” companies.
- **Lead companies coordinate specialized companies to develop and maintain oil and gas wells.** Like general contractors in the construction industry, lead OGE companies do not employ all workers on a given work site. Lead companies may, in fact, employ very few onsite workers. Lead companies are specialized in their own way, since they must understand how the functions of specialized companies need to be integrated to achieve a productive well. A key tool for the coordination of subcontractor and specialized companies is a set of standards that are typically codified and enforced through legal contracts between lead and specialist companies. Enforcement of contractual terms is necessary to ensure both that specialized companies meet the lead companies’ standards and that lead companies meet their responsibilities to specialized companies as the work unfolds. There may be a considerable number of specialized companies that contract with a given lead company, or its contractors, for a particular project. This bevy of contracts has the potential to create a substantial administrative burden, especially for the lead company. One common strategy to reduce administrative burden and contracting costs is a two-stage contracting process that includes (1) a master service agreement that articulates broad terms and conditions applicable to various types of specific work activities and (2) detailed work orders that articulate specific terms of a given job, such as the cost and when the job will begin. Additionally, lead companies routinely hire specialized companies that have developed—as their core competencies—digital platforms and other methods (for example, trainings and audits) to support lead companies’ contractor management tasks.

Ensuring the safety and health of OGE workers is an important dimension of the management of any OGE operation, given the diversity of occupational hazards and the potentially fatal consequences of exposure to those hazards.⁴ To that end, both lead and specialized OGE companies often employ dedicated safety and health professionals to manage internal policies and programs and promote safe practices among front-line workers. However, lead OGE companies also set standards for safety performance in their contracts with specialists and ensure compliance using audits, incident reviews, and other tactics. Lead companies’ standards may sometimes exceed regulatory requirements and address issues for which no Occupational Safety and Health Administration (OSHA) standard exists, such as new and emerging technologies with implications for occupational safety and health. For example, a lead company may require a contracted specialist to use an in-vehicle monitoring system to manage risks related to occupational driving, the leading cause of workplace fatalities in OGE.

How are establishments in the oil and gas extraction industry classified?

Given the potentially complex network of lead companies and specialized contractors, and the diversity of tasks that may be required to develop an oil or gas well, it may be difficult or impossible to devise a universal definition of the OGE workforce applicable to all research studies. Instead, researchers should carefully define the dimensions of the OGE workforce that are relevant to their research projects and clarify the rationale for including or excluding certain groups from their estimates. Economic and health studies pertaining to OGE workers typically rely on hierarchical industrial and occupational coding systems used by the U.S. federal government to classify OGE businesses and workers.⁵ With public data, understanding the industrial and occupational codes relevant to OGE is the first step in estimating the size of the OGE workforce. This article focuses primarily on classifying the OGE workforce by establishments’ industrial codes, rather than by occupational codes (such as the Standard Occupational Classification codes), although additional analysis of data by occupational code can yield rich insights.⁶

The North American Industrial Classification System (NAICS), established in 1997, includes a hierarchical system of NAICS codes, assigned to the primary business activity of an establishment. Typically, an establishment refers to a specific physical location where business is conducted. However, in dispersed and shifting operations such as with oil and gas wells, the establishment can be defined by a permanent location (for example, an office) that supervises the dispersed activities or that serves as a base from which personnel operate. Establishments may be further grouped into firms or enterprises. The NAICS codes classify establishments into sectors, subsectors, industry groups, industries, and industries specific to a given North American country using two, three, four, five, or six digits, respectively. In this article, we sometimes use the term “companies,” which could refer to establishments, firms, or enterprises. Companies, whether consisting of a single or multiple establishments, are entities that employ workers. It should be kept in mind, though, that government data sources typically classify workers at the establishment level. We therefore use the more precise term “establishment” when referring to specific government data. The two subsectors and four U.S. industries commonly used to define the OGE workforce are,⁷

- Oil and gas extraction (NAICS 211)
- Crude petroleum extraction (NAICS 211120)
- Natural gas extraction (NAICS 211130)
- Support activities for mining (NAICS 213)
- Drilling oil and gas wells (NAICS 213111)
- Support activities for oil and gas operations (NAICS 213112)

Industrial codes developed by the U.S. Census Bureau for use in the decennial census and related surveys (for example, the American Community Survey) are derived from NAICS codes and correspond to them closely, but they are somewhat less detailed than NAICS codes and more suited to population surveys.⁸ Census industrial codes 0370 and 0490 are equivalent to NAICS subsectors 211 and 213. Unlike NAICS, Census codes are not available to further specify the type of activity within NAICS 213/Census 0490 (for example, oil and gas drilling) or even whether the establishment works in mining or OGE.

The logic of including workers employed by specialized OGE establishments in the definition of the OGE industry is supported by the fact that most injuries in these drilling and support industries occur at OGE worksites managed by lead establishments or occur on the way to or from these worksites. In addition, safety and health researchers have particular reasons not to exclude drilling and servicing employees. Fatal injury and workers' compensation claim rates, for example, are higher among specialized companies (like companies in NAICS 213111 and 213112) than among lead companies (like companies in NAICS 211).⁹ Accordingly, the National Institute for Occupational Safety and Health (NIOSH) includes OGE companies specializing in drilling and servicing activities in its OGE sector research program.¹⁰

In common parlance of the OGE industry, the term “operator” is often used to describe companies in NAICS 211 (or Census industrial code 0370) and the term “contractor” is often used to describe companies in NAICS 213111, 213112, or in some other industry that provides services to companies in NAICS 211, such as a transportation company. Per the definition of NAICS 211, establishments in NAICS 211 can also sometimes act as a contractor. This might suggest that they may sometimes play the role of a specialist company. However, establishments in NAICS 211 sometimes contract with other establishments in NAICS 211 in ways that do not indicate a specialist role. This may happen when, for example, work associated with a contract between operator A and contractor B has been completed ahead of schedule. Another operator C may then contract with operator A to enable it to use the services of contractor B during the remaining term of its existing contract with operator A. In this case, operator companies are contracting with each other only to share the use of the specialized services of a contractor. Currently, we lack the detailed data needed to rule out the possibility that some companies in NAICS 211 contract with other operator companies to perform specialized contractor services. However, acknowledging these uncertainties and nuances, we have chosen to refer to establishments and companies in NAICS 211 as lead companies and to establishments and companies in NAICS 213 as specialist companies, to describe the roles that these companies generally serve in the development and production process.

Other industry classification systems, rooted in actuarial science, have been developed by various states and the National Council for Compensation Insurance (NCCI) for administering workers’ compensation insurance.¹¹ Workers’ compensation class code systems vary by state, along with other workers’ compensation laws and policies. NCCI class codes have been adopted by 35 states and the District of Columbia, although even among NCCI states there are variations in the class codes that are used.¹² Class codes are designed to group together establishments with similar risk profiles in order to support the setting of insurance premiums. Class codes can sometimes be more specific than NAICS six-digit codes. Thus, class codes possibly serve as a useful way of classifying OGE establishments and companies. However, there are at least three differences between class code systems and NAICS to consider. First, clerical employees, drivers, and off-premises salespeople are classified separately, regardless of the main class code assigned to a workforce. Second, class codes are assigned to segments of a workforce on a company level across all of its establishments. Third, and most importantly, the size of workforces in workers’ compensation systems is generally measured not by the number of employees but by dollars of payroll. Dollars of payroll is not the ideal metric for measuring workforce size or calculating rates of occupational injury and illness since payroll is a function of both the number of workers and total wages per worker. Additionally, users of class codes should be aware that workers’ compensation data include an unknown proportion of self-employed workers.

Measuring and describing the OGE workforce

In the sections below, we use several public data sources to describe the U.S. OGE workforce along several dimensions, including but not limited to employment levels by company role (lead versus specialist) and across time and geography. We also summarize safety and health differences between lead and specialist companies. Researchers focused on other industries could follow a similar approach with the same data sources.

Most OGE workers are employed by specialized companies that contract with lead companies

In 2022, oil and gas drilling and servicing establishments employed over two-thirds of U.S. OGE workers (see table 1). Thus, if researchers were to exclude employees of specialized OGE establishments from U.S. OGE workforce estimates because of the title of NAICS 213 (support activities for mining), they would drastically underestimate the total workforce. Excluding specialized OGE establishments would also give a biased view of workers in the industry because OGE operators and contractors differ in terms of their employees’ tasks, working conditions, and demographic characteristics.

Table 1. Employment in the U.S. oil and gas extraction industry by establishment role, type, and NAICS code, 2022

Establishment role(s)	Establishment type (NAICS terminology)	NAICS code(s)	Number of workers	Percent of total employees (361,858 workers)	Percent of specialist employees (249,858 workers)
Lead	Oil and gas extraction	211	112,702	31	¹
Specialist	Drilling oil and gas wells	213111	47,357	13	19
Specialist	Support activities for oil and gas operations	213112	201,799	56	81
Specialist	Drilling oil and gas wells and support activities for oil and gas operations	213111 and 213112	249,156	69	100
Lead and specialist	Total	211 and 213111 and 213112	361,858	100	¹

¹ Not applicable.
Note: NAICS = North American Industrial Classification System. The terms "lead" and "specialist" are not official NAICS terms. These terms are used to distinguish between establishments that oversee all aspects of oil and gas extraction for a given location and establishments that perform specialized services on behalf of lead establishments, such as through contracts. In addition to coordinating activities for a location, a lead establishment may perform some or all of the drilling and support tasks frequently performed by specialist establishments.
Source: U.S. Bureau of Labor Statistics Quarterly Census of Employment and Wages.

As table 2 shows, specialized OGE establishments are only separately identified at the detailed NAICS six-digit code level, which is unavailable in many data sources. However, as table 2 also shows, specialized OGE establishments represent a far larger share of the support activities for mining subsector (NAICS 213), at 95 percent, than do specialized mining establishments.

Table 2. Composition of specialized establishments in the support activities for mining subsector (NAICS 213), 2022

Establishment type	NAICS code(s)	Number of workers	Percent of subsector
Drilling oil and gas wells	213111	47,357	18
Support activities for oil and gas operations	213112	201,799	77
Support activities for coal mining	213113	4,409	2
Support activities for metal mining	213114	4,944	2
Support activities for nonmetallic minerals (except fuels) mining	213115	3,296	1
Oil and gas specialists	213111 and 213112	249,156	95
Mining specialists	213113 and 213114 and 213115	12,649	5
Support activities for mining	213	261,805	100

Note: NAICS = North American Industrial Classification System. "Specialists" is not an official NAICS term. Stratifying the entire three-digit NAICS code for support activities for mining (213) by six-digit NAICS codes demonstrates that 95 percent of workers in NAICS 213 are employed by establishments specializing in oil and gas extraction.

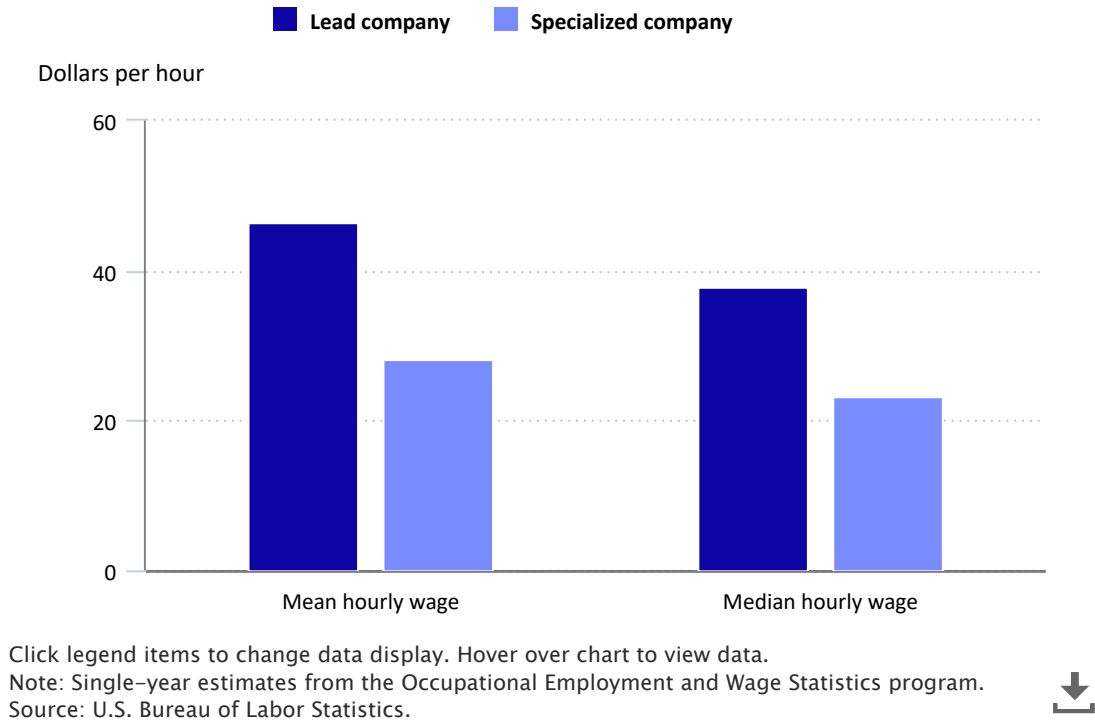
Source: U.S. Bureau of Labor Statistics Quarterly Census of Employment and Wages.

This distribution of employment indicates that, when using data sources that only include data at the three- or four-digit level, including all NAICS 213 workers in the OGE industry count is a better option than excluding employees of specialized OGE establishments altogether. This is the option we take throughout this article when applicable.

The difference in occupational profiles of lead and specialized OGE companies

Public workforce data indicate that there are differences between the distributions of occupations in lead companies and specialized companies. These differences suggest the need for subgroup analysis. These occupational data can be useful for identifying and quantifying subgroups within the OGE workforce who have particularly high exposure to occupational hazards, and, more broadly, these data are increasingly recognized as representing social determinants of health.¹³ The Occupational Employment and Wages Survey (OEWS) provides the distribution of occupations within each industry.¹⁴ Consider only the employees in the most common occupations among lead and specialized companies (representing approximately 86 percent of total employment in each type of company during 2019). Among lead companies, only 31 percent in this group are in more physically taxing production occupations. Meanwhile, among specialized companies this figure is 83 percent. The top production occupation for both lead and specialized OGE companies is “extraction worker,” but this occupation accounts for only 10 percent of total employment among lead companies, and 37 percent of total employment among specialist companies. The difference in the mix of occupations among the two types of companies helps explain why mean hourly wages are approximately 40 percent lower among specialist companies (see chart 1). However, the difference in occupational mix does not entirely explain the difference in pay. Just comparing extraction workers in 2019, those who worked for lead companies received median pay of \$27.52 per hour, while those working for specialist companies received \$21.70 per hour.¹⁵

Chart 1. Wage differences between workers employed by lead and specialized companies in oil and gas extraction, 2019

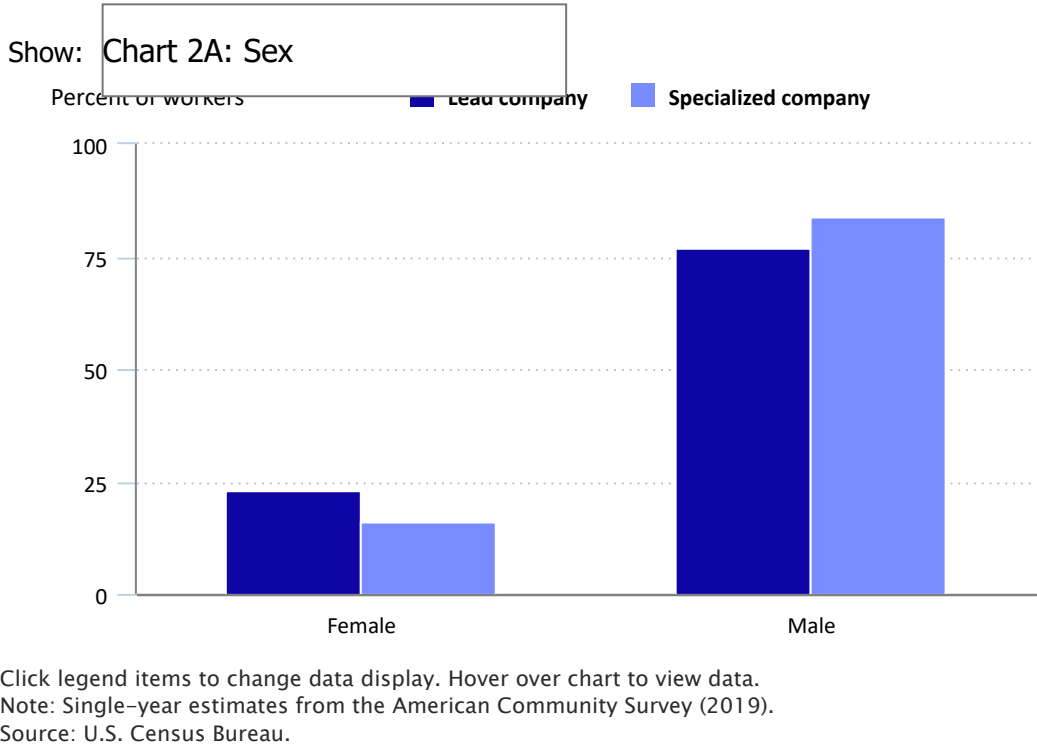


to diesel exhaust, than lead company employees.¹⁷ Specialist company employees are also more likely to work more hours per week, on average, than lead company employees.¹⁸

Differing demographics of lead OGE companies and specialized OGE companies employees

Lead and specialized companies differ not only in pay levels and the work they perform but also in the demographic characteristics of the people they employ. We present weighted single-year estimates of the distribution of workers across demographic subgroups from the 2019 American Community Survey (ACS) (see chart 2). Compared with OGE lead companies, specialized OGE companies employed proportionally more workers who were male, non-White, Hispanic, younger (20–24 and 25–34), and of lower educational attainment. These differences can translate into differences in vulnerabilities to hazards and in approaches to prevention, and thus represent a need to separately examine and describe these workforce subgroups.

Chart 2. Sociodemographic differences between workers employed by lead and specialized companies in oil and gas extraction, 2019



[View Chart Data](#)

Population surveys and employer-reported data sources produce differing estimates of OGE workforce size

We obtained the OGE employment figures in table 1 from the U.S. Bureau of Labor Statistics (BLS) Quarterly Census of Employment and Wages (QCEW), and they show issues related to inclusion and differentiation of OGE industry components. However, there are several data sources that provide data on employment levels in the industry, and they do not always agree. Table 3 compiles employment estimates from eight data sources and lists a ninth that promises to be available in the future.¹⁹ The data sources include the ACS, County Business Patterns (CBP), Current Employment Statistics (CES), Current Population Survey (CPS), the BLS Office of Productivity and Technology (OPT), OEWS, QCEW, Quarterly Workforce Indicators (QWI), and Nonemployer Statistics (NES).²⁰ Unfortunately, the ranges of these estimates are large, and it is beyond the scope of this article to explore the reasons for this. No single source provides definitive information on employment levels. Additionally, workforce data sources also vary widely in the type of additional information available on OGE workers. This variation in additional information is another reason to consult more than one source. An additional feature of table 3 is a column showing the impact of each employment estimate on calculation of the estimated annual incidence of occupational fatalities per 100,000 workers. The number of fatal occupational injuries reported by the BLS Census of Fatal Occupational Injuries serves as the incidence estimate’s numerator and each data source provides the estimate’s denominator.

Table 3. Comparison of data sources for oil and gas extraction worker statistics, 2019

Data source	Collection method	Number of lead company employees or jobs	Number of specialist company employees or jobs	Total number of employees or jobs	Estimated annual incidence of fatal occupational injuries ¹	Collection agency	Classification	Strengths	Limitations
County Business Patterns	Establishment	108.1	341	449.1	23.2	BLS	NAICS codes	Census of employers, not a survey Rich geographic detail	No demographic or work hours information
Current Employment Statistics	Establishment	143.6	344.2	487.8	21.3	BLS	NAICS codes	Survey of establishments Large sample; rich industry detail State-level data available Provides recent monthly data	Not a census NAICS codes are limited to three-digit codes, prohibiting comparisons between specialized OGE companies Geographic location tied to job, rather than household, limiting valid comparisons to population surveys On state level data mostly limited to production workers
Labor Productivity and Costs	Establishment	144.6	353.9	498.5	20.9	BLS	NAICS codes	Data available for all years beginning in 1987 Annual data revisions incorporate revisions for all prior years Includes industry-level data on work hours	Data available only on national level No demographic information Aggregate industry-level data only NAICS codes are limited to four-digit codes, prohibiting comparisons between drillers and other OGE specialists within NAICS 213
Occupational Employment and Wage Statistics	Establishment	141.3	349.3	490.6	21.2	BLS	NAICS codes	Detailed data available on detailed occupations within each industry, by state Data available on wage distribution by industry and occupation	Each year's report draws on 3 years of data so sudden changes in employment and wages not fully incorporated No demographic information Geographic location tied to job, rather than household, limiting valid comparisons to population surveys
Quarterly Census of Employment and Wages	Establishment	141.7	342.2	483.9	21.5	BLS	NAICS codes	Establishment-based census of workers covered by unemployment insurance Data are released monthly Detailed NAICS codes (six-digit) are available	No demographic information. Geographic location tied to job, rather than household, limiting valid comparisons to population surveys
Quarterly Workforce Indicators	Establishment	²	²	²	²	USCB	NAICS codes	Combines demographic information with QCEW data State-level data are available	NAICS codes are limited to three-digit codes, prohibiting comparisons between drillers and other OGE specialists within NAICS 213

Data source	Collection method	Number of lead company employees or jobs	Number of specialist company employees or jobs	Total number of employees or jobs	Estimated annual incidence of fatal occupational injuries ¹	Collection agency	Classification	Strengths	Limitations
									Demographics limited to three combinations of characteristics (sex and age, sex and education, race and ethnicity) National data are only in beta testing
American Community Survey	Individuals	141	443.9	584.9	17.8	USCB	Census codes (equivalent to NAICS codes at the three-digit level)	Population-based survey Large (~2.3 million households) Rich sociodemographic and geographic information Can support FTE-based analyses Rich geographic detail	Not a census Census codes prohibit comparisons between OGE specialists Data released around 9 to 10 months after end of applicable year
Current Population Survey	Individuals	98.9	474.8	672.6	15.5	USCB and BLS	Census codes (equivalent to NAICS codes at the three-digit level)	Population-based survey High response rate Extensive work-related information	Data available on state level but samples often too small to produce reliable estimates for small industries like OGE
Nonemployer Statistics sole proprietors	Individuals	39.7	15.7	55.4	²	USCB	NAICS codes	Based on all U.S. tax returns Captures independent contractors not represented in other employer surveys and censuses	NAICS codes are limited to four-digit codes, prohibiting comparisons between drillers and other OGE specialists within NAICS 213.
Nonemployer Statistics corporations and partnerships	Individuals	13.7	4.6	18.3	²	USCB	NAICS codes	Based on all U.S. tax returns Captures independent contractors not represented in other employer surveys and censuses	NAICS codes are limited to four-digit codes, prohibiting comparisons between drillers and other OGE specialists within NAICS 213

¹ The estimated annual fatality incidence per 100,000 workers. The BLS Census of Fatal Occupational Injuries reported 104 fatal occupational injuries during 2019 among workers in NAICS 211, 213111, and 213112.

² Not applicable.

Note: BLS = U.S. Bureau of Labor Statistics; NAICS = North American Industrial Classification System; OGE = oil and gas extraction; USCB = U.S. Census Bureau. All reported numbers of jobs or employees are in 100,000s. Population-based surveys count workers. Establishment surveys and censuses count jobs. Lead company statistics are either from NAICS 211 or Census Code 0370, and specialist company statistics are either from NAICS 213 or Census code 0490, depending on the data source listed. The year 2019 was selected both to allow for standardized comparisons across data sources and to eliminate any differential impacts the COVID-19 pandemic may have had on these diverse data sources and worker populations. Source: U.S. Bureau of Labor Statistics and U.S. Census Bureau.

One major factor that may help to explain differences in the estimates is the differences between population surveys of individuals (and households) and surveys (or censuses) of employers. Individual workers are not as likely to understand how to characterize their industry as well as their employers can, and workers usually only participate in a survey once, whereas most employers are repeatedly queried about their industry. In addition, data agency personnel can recontact employers when necessary to ask for more information about principal activities and processes, and industrial codes of employers are periodically audited and crosschecked among data programs.²¹

In table 3, the included population surveys are the ACS and CPS. The other data sources in table 3 are employer-reported data, with the partial exception of the OPT data, which are based primarily on employer-reported data but are supplemented with data from the CPS and other sources.

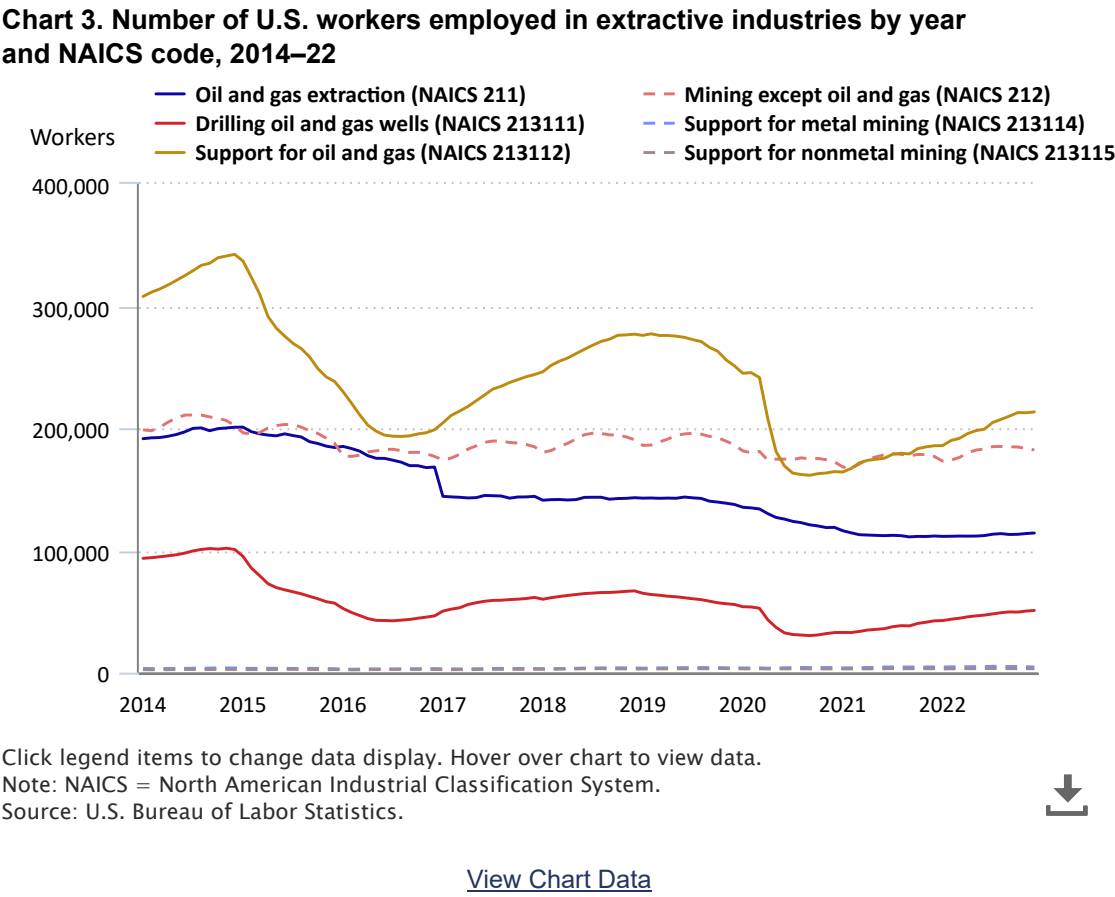
Another basic difference between the population surveys and employer-based data sources is that population surveys are usually used to measure the number of workers (with workers classified to industry on the basis of their primary job), whereas employer-based sources report the number of jobs.²² As some workers have more than one job, employer-based sources tend to produce higher employment estimates. This is not the case for the OGE industry, indicating that there are other factors that explain the differences between population surveys and employer-based estimates.

Total OGE employment is notably higher in the two population surveys and is especially high in the CPS. Both of these sources report much higher employment than the employer-based sources for specialized companies but not for lead companies. At the same time, the CPS reports much lower employment for lead companies than the other data sources, although one of the employer-based data sources, CBP, also reports relatively low lead company employment. Other differences in employment estimates from different sources in table 3 are relatively modest.

At the bottom of table 3, employment estimates from the NES program at the U.S. Census Bureau are presented. These have been included because several employer data sources in table 3, including CPB, CES, OEWS, QCEW, and QWI do not include independent contractors or any other businesses that do not have employees. NES data are designed to capture information on this group. There is limited information available on these contractors and business entities. Not all of them may be represented in tax return data, and some businesses for which returns are filed may be entities that exist only on paper and in which no one works. Nevertheless, the NES estimates give some indication of the potential number of workers in OGE who do not work within employer businesses. Note that these workers are already included in the employment figures from the two population surveys (ACS and CPS) and from OPT data, which do not rely exclusively on employer-reported data. If the NES numbers are added to the employer data source estimates, total employment estimates from these sources begin to approach the total from the ACS but are still much below the CPS estimate. Of note is that the total number of OGE respondents to the ACS and CPS who identify themselves as self-employed is much lower than the NES figures. For example, the ACS estimate of self-employed operators was 4,697, of which 1,623 were not incorporated, and the ACS estimate of self-employed contractor workers was 20,651, of which 10,339 were not incorporated.²³ Not all of these self-employed workers should be added to the totals from the employer-based data sources because some of them have employees and are likely already to be included in employer-based data sources. Much of the discrepancy between the NES figures and the self-employment survey estimates may be explained by the fact that there are likely to be a substantial number of ACS and CPS survey respondents who report that they are an employee but are nevertheless treated as independent contractors for tax purposes and appear in NES data rather than in the employer-based data sources.²⁴

Changes in the OGE workforce over time

Over recent decades, there has been a shift of employment within the OGE industry, from lead establishments in NAICS 211 to specialist establishments in NAICS 213111 and 213112. For every employee in NAICS 211 from 1990 to 1994, there were 0.86 employees in NAICS 213111 and 213112 combined. By the 2018 to 2022 period, specialist employees outnumbered lead employees, with a ratio of 2.1 specialist employees per 1.0 lead employee.²⁵ However, of more interest in the short to medium run is the magnitude of fluctuations in the lead and specialist workforces. Business cycles in OGE are inherently related to volatility in supply and demand of oil and gas in the world market, which together drive price and demand for workers. Geopolitics, weather, and other factors can quickly impact prices and employment.²⁶ For example, the COVID-19 pandemic decreased economic activity and demand for oil. Simultaneous geopolitical conflict led to overproduction. The combination of low demand and high supply led to a price crash and layoffs among U.S. OGE workers.²⁷ Other examples are hurricanes in the Gulf of Mexico that slow drilling and refining activities in the region, limiting supply and suddenly increasing oil prices, and the proliferation of hydraulic fracturing technologies that rapidly increased the supply of oil and gas reserves and the number of people working in the industry.²⁸ Chart 3, using 2014–22 data from the QCEW, shows that specialized OGE establishments (NAICS 213111 and 213112) have experienced greater fluctuations in employment over time compared with lead OGE establishments (NAICS 211). Chart 3 also includes data for all components of the mining sector (NAICS 21), for additional context.



The magnitude of fluctuations in OGE employment are summarized in table 4.

Table 4. Variability in oil and gas extraction employment by NAICS Code, 2014–22

Variables	Oil and gas extraction (211)	Drilling oil and gas wells (213111)	Support for oil and gas operations (213112)
Mean monthly employment	149,276	57,618	237,325
Standard deviation	30,413	18,853	50,626
Relative standard deviation	20 percent	33 percent	21 percent
Maximum employment	200,916	101,828	342,287
Minimum employment	111,141	30,350	161,514
Max–min difference	89,775	71,478	180,773
Max–min difference as percent of mean monthly employment	60 percent	124 percent	76 percent

Note: NAICS = North American Industrial Classification System; QCEW = Quarterly Census of Employment and Wages.

Source: U.S. Bureau of Labor Statistics Quarterly Census of Employment and Wages.

During the 2014–22 period, the absolute difference between maximum and minimum monthly employment was higher among specialized OGE establishments. Drilling establishments witnessed the greatest relative fluctuation during this period. The difference between the maximum and minimum monthly employment of drilling workers was 124 percent of the mean number of workers. Overall, the relative fluctuations in OGE employment among establishments that drill oil and gas wells or provide support to oil and gas operations were greater than among lead OGE establishments, indicating less secure employment. Other indicators reinforce this point. Chart 4 displays the proportions of workers employed in a given OGE subsector during the first quarter of each year from 2000–22 who were newly hired during that quarter or who separated from their jobs due to any reason. Both proportions are higher among specialized OGE establishments than among lead establishments.

Chart 4. Oil and gas extraction workers, percent new hires and separations in Q1, 2000–22, by NAICS code, in select states

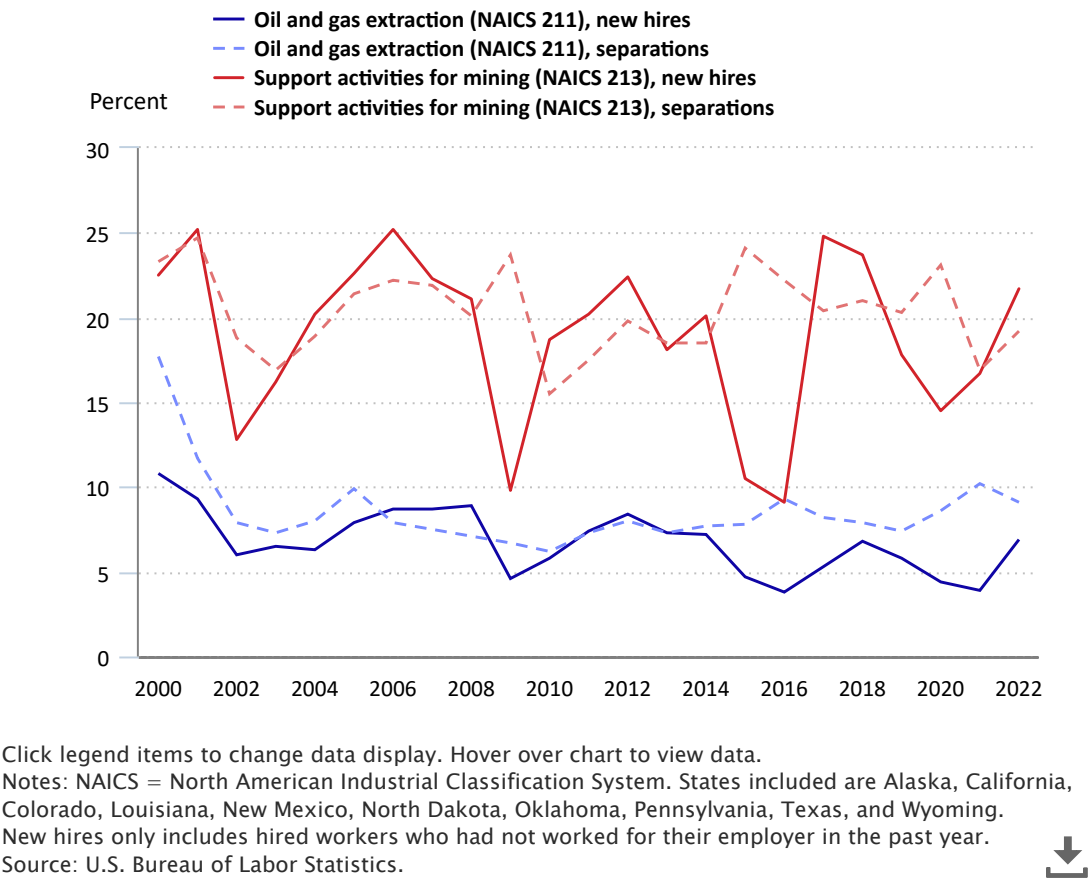


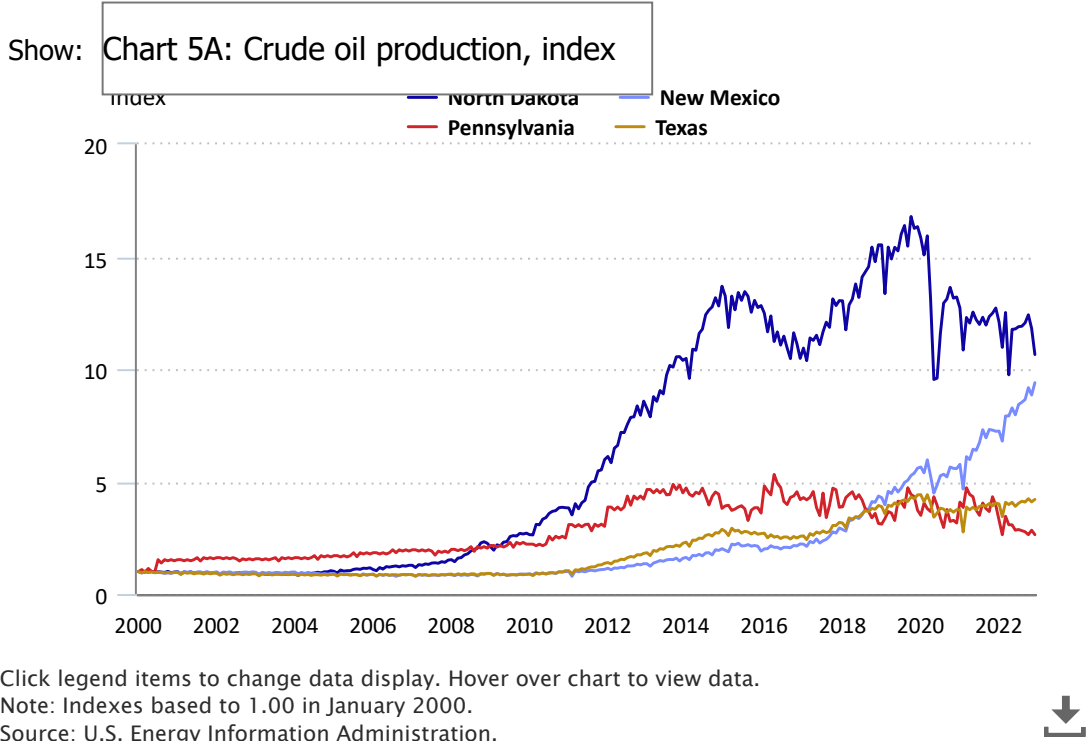
Table 5. Number and percent of oil and gas extraction workers employed per month in each state, overall and by NAICS code, 2022

State	Oil and gas extraction (211)	Drilling oil and gas wells (213111)	Support activities for oil and gas operations (213112)	Overall	Percent	Cumulative percent of U.S. total
Texas	60,120	24,178	101,414	185,712	51.9	51.9
Oklahoma	11,957	2,470	13,714	28,141	7.9	59.8
Louisiana	5,314	3,325	19,295	27,934	7.8	67.6
New Mexico	4,188	3,246	10,286	17,720	5.0	72.6
Colorado	6,686	1,096	8,607	16,389	4.6	77.2
Pennsylvania	3,601	1,224	7,257	12,082	3.4	80.6
North Dakota	2,439	0	9,468	11,907	3.3	83.9
California	3,327	2,078	5,635	11,040	3.1	87.0
Wyoming	2,221	1,026	5,164	8,411	2.4	89.4
Alaska	2,783	514	3,741	7,038	2.0	91.4
West Virginia	1,795	1,093	2,245	5,133	1.4	92.8
Ohio	1,231	374	3,023	4,628	1.3	94.1
Kansas	1,737	0	2,183	3,920	1.1	95.2
Utah	894	515	2,240	3,649	1.0	96.2
Mississippi	399	0	1,429	1,828	0.5	96.7
Illinois	720	213	839	1,772	0.5	97.2
Michigan	566	258	889	1,713	0.5	97.7
Montana	416	94	934	1,444	0.4	98.1
Arkansas	443	54	928	1,425	0.4	98.5
Alabama	342	0	450	792	0.2	98.7
Kentucky	444	173	166	783	0.2	98.9
Florida	60	254	292	606	0.2	99.1
Virginia	188	168	196	552	0.2	99.3
New York	168	147	208	523	0.1	99.4
Indiana	105	220	0	325	0.1	99.5
North Carolina	0	152	138	290	0.1	99.6
Tennessee	49	74	156	279	0.1	99.7
Georgia	13	116	139	268	0.1	99.8
Nebraska	54	58	99	211	0.1	99.9
Maryland	45	83	32	160	0.0	99.9
New Jersey	17	24	117	158	0.0	99.9
Nevada	12	0	96	108	0.0	99.9
Arizona	68	12	23	103	0.0	99.9
Idaho	13	15	73	101	0.0	99.9
South Carolina	10	38	53	101	0.0	99.9
Missouri	19	23	57	99	0.0	99.9
Minnesota	80	0	11	91	0.0	99.9
South Dakota	0	0	37	37	0.0	99.9
Wisconsin	0	0	27	27	0.0	99.9
Massachusetts	0	8	15	23	0.0	99.9
Washington	0	17	0	17	0.0	99.9
Oregon	0	10	5	15	0.0	99.9
Iowa	0	10	0	10	0.0	99.9
Connecticut	0	0	6	6	0.0	99.9
Total	112,524	43,360	201,687	357,571	100.0	100.0
Note: NAICS = North American Industrial Classification System. States are ranked by total oil and gas extraction (OGE) employment during 2020 and figures may not match exact totals because of rounding. Delaware, Hawaii, Maine, New Hampshire, Rhode Island, and Vermont each reported zero OGE workers, on average, in 2020. Not all workers are assigned states, so the overall totals and the totals for some states are higher than these official numbers. Also, there is no way of distinguishing between onshore and offshore workers. Source: U.S. Bureau of Labor Statistics.						

Although table 5 has all workers assigned to one state or another, determining the state location of workers can be particularly problematic in the OGE industry. Remote areas with small populations often lack a sufficient number of workers with the full range of specialized skills and equipment required for OGE development. This lack of workers often motivates OGE companies to contract with companies specializing in particular aspects of OGE who are headquartered far from the wellsite. It is also common for workers to travel to a wellsite far from home. A study from Pennsylvania estimated that of the approximately 18,761 jobs created in Pennsylvania from 2005–11 as a result of OGE development, fewer than half were filled by local residents (7,346, 39 percent).³¹ It is important when using geographic information that researchers are clear as to whether they are capturing where workers live, the worksite location, or the employer location where the jobs are administratively based, which can be different from the worksite. Note that population surveys typically focus on place of residence but employer data sources are focused on administrative or work locations.

Not only do states have very different overall levels of OGE employment, they also have different mixes of oil and gas production and experience different trends in production and employment. Chart 5 displays variability in oil and gas production, work activities, and employment from 2000 to 2022 in four states that produce relatively large amounts of oil and gas (North Dakota, New Mexico, Pennsylvania, and Texas).

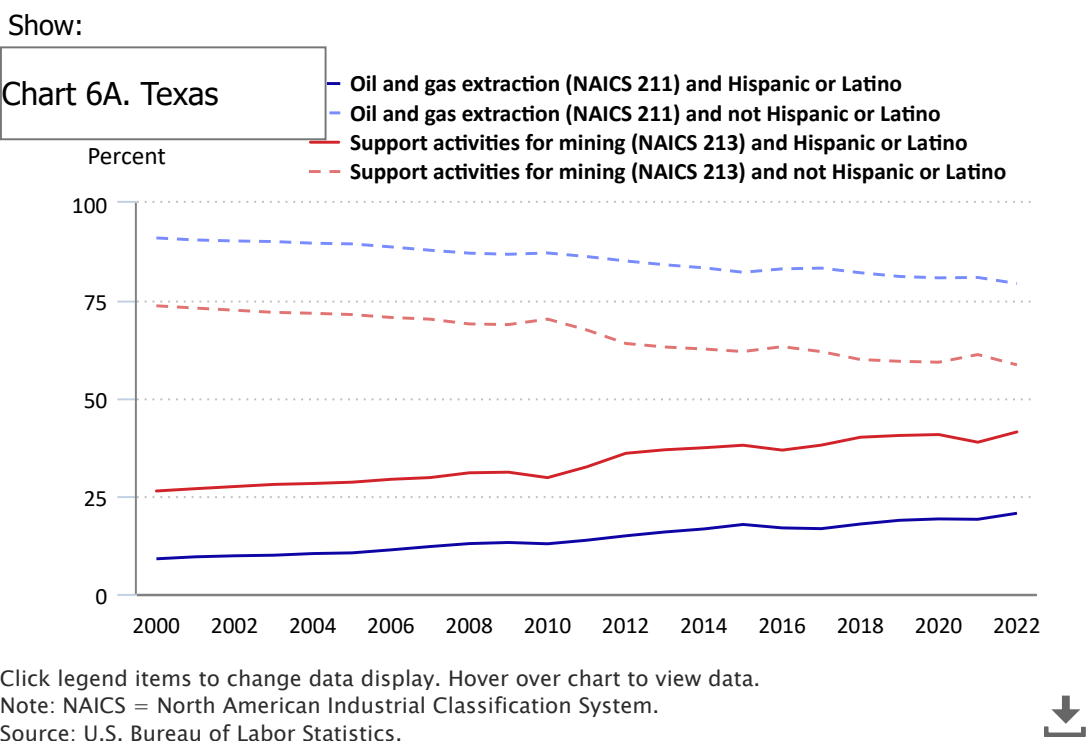
Chart 5. Production and employment trends in oil and natural gas, in select states, 2000–22



These four states all rank in the top 10 oil or gas producing states and we selected them to demonstrate several points. Texas again stands out in each chart as the leader in oil production, gas production, rotary rig activity, and OGE employment. Pennsylvania produces natural gas approaching Texas levels but has very little crude oil production and far fewer workers. North Dakota produces more oil than natural gas. Time trends also differed by state. The impact of hydraulic fracturing on resource accessibility, prices, and profitability of particular locations from 2010 to 2014 appears to some degree in all states, but in relative terms, the change in OGE employment was much greater in North Dakota and Pennsylvania than in Texas and New Mexico. At the same time, the absolute magnitude of changes in employment were still much larger in Texas because of its much higher level of production. The relative change in production of oil and gas also differed among states. North Dakota saw by far the greatest relative increase in oil production, while Pennsylvania saw by far the largest relative increase in natural gas production.

The demographic characteristics of OGE worker populations also vary by state and over time. For example, workers with Hispanic or Latino ethnicity have become an increasingly important part of the OGE workforce over the past two decades. Each of the four states discussed previously have seen a notable increase in the share of workers who are Hispanic, but these increases have been larger in magnitude in Texas and New Mexico where Hispanic workers were already a larger share of the workforce. Hispanic workers were also larger share among specialized establishments (NAICS 213) than among lead establishments (NAICS 211). See chart 6.

Chart 6. Percent of U.S. oil and gas extraction workers by NAICS code and Hispanic ethnicity, in select states, 2000–22



Considerations for future research

Future research on the OGE workforce could involve (1) more detailed exploration of available federal data sources, (2) collecting additional primary research data, or (3) partnering with organizations holding privately held data that could complement federal data sources. Among the specific topics suggested by the information presented in this primer are the following:

- The frequency with which “specialized” activities, such as drilling and servicing, are performed by employees of lead companies (e.g., in NAICS 211) and how the division of activities between lead and specialized companies affects worker pay, working conditions, and safety. More insight into the sets of activities performed by lead and specialized companies might be obtained using state-level QCEW data. That data could illustrate how NAICS-coded establishments are grouped within enterprises. Additional research using interviews and researcher-initiated special surveys may be useful for understanding the reasons for performing certain activities in-house versus contracting them out.
- Why counts of workers from population-based surveys are typically greater than counts of jobs from employer-based surveys and censuses, and why, within each of these two groups of data sources, there are some substantial differences in counts.
- How workers and jobs are distributed among counties as well as among states, and how this geographical distribution and its changes are related to commute times, turnover, and worker migration.

Conclusions

Workforce research can be useful to managers and policymakers in the OGE industry for understanding worker needs and improving the allocation of resources toward worker training, retention, benefits, and worker health and safety programs. This article has illustrated how multiple federal data sources can be used to assemble a rich description of the OGE workforce. It has shown that this workforce is divided between lead and specialized employers and that the characteristics and working conditions of these two groups differ significantly. Further, it has shown how OGE employment is volatile and geographically concentrated. The information presented here also points to the potential usefulness of additional data on the OGE workforce.

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Notes

¹ Gavin C. Pickenpaugh and Justin M. Adder, “Shale gas production and labor market trends in the U.S. Marcellus–Utica region over the last decade,” *Monthly Labor Review*, August 2018, <https://doi.org/10.21916/mlr.2018.20>.

² Natalie Burclaff and Michael Ratner, “Upstream: production and exploration,” *Oil and Gas Industry: A Research Guide* (Library of Congress, August 2022), <https://guides.loc.gov/oil-and-gas-industry/upstream>.

³ David Weil’s 2014 book from Harvard University Press, *The Fissured Workplace: Why Work Became So Bad for So Many and What Can Be Done to Improve It*, describes the fissured workplace as follows: “[The] fissured workplace represents a response to pressures from capital markets and is enabled by the falling cost of coordinating business transactions through information and communication technologies…” and integrates three distinct strategic elements, “the first [element] focused on revenues (a laser-like focus on core competencies), the second focused on costs (shedding employment), and the final one providing the glue to make the overall strategy operate effectively (creating and enforcing standards),” pp. 10–11. We borrow Weil’s terminology to describe companies in oil and gas extraction (OGE). We use the terms specialist and specialized companies to describe the companies “orbiting around” lead OGE companies (Weil’s terminology, e.g., p. 43).

⁴ See Kaitlin C. Wingate, Kenneth A. Scott, Stephanie G. Pratt, Bradley King, Eric J. Esswein, Alejandra Ramirez-Cardenas, John Snawder and Kyla Hagan-Haynes, “Self-reported exposure to hazards and mitigation strategies among oil and gas extraction workers in three U.S. states,” *Journal of Occupational and Environmental Hygiene*, vol. 19, no. 10–11, October 2022, pp. 676–689, <https://doi.org/10.1080/15459624.2022.2123496>; Kyla D. Retzer, Ryan D. Hill, and Stephanie G. Pratt, “Motor vehicle fatalities among oil and gas extraction workers,” *Accident Analysis & Prevention*, vol. 51, March 2013, pp. 168–174, <https://doi.org/10.1016/j.aap.2012.11.005>; Krystal L. Mason, Kyla D. Retzer, Ryan D. Hill, and Jennifer M. Lincoln, “Occupational fatalities resulting from falls in the oil and gas extraction industry, United States, 2005–2014,” *Morbidity and Mortality Weekly Report (MMWR)*, vol. 66, no. 16, April 28, 2017, pp. 417–421, <https://www.cdc.gov/mmwr/volumes/66/wr/mm6616a2.htm>; Krystal L. Mason, Kyla D. Retzer, Ryan D. Hill, and Jennifer M. Lincoln, “Occupational fatalities during the oil and gas boom—United States, 2003–2013,” *Morbidity and Mortality Weekly Report (MMWR)*, vol. 64, no. 20, May 29, 2015, pp. 551–554, <https://www.cdc.gov/mmwr/preview/mmwrhtml/mm6420a4.htm?s>; Robert J. Harrison, Kyla Retzer, Michael J. Kosnett, Michael Hodgson, Todd Jordan, Sophia Ridl, and Max Kiefer, “Sudden deaths among oil and gas extraction workers resulting from oxygen deficiency and inhalation of hydrocarbon gases and vapors—United States, January 2010–March 2015,” *Morbidity and Mortality Weekly Report (MMWR)*, vol. 65, no. 1, January 15, 2016, pp. 6–9, <https://www.cdc.gov/mmwr/volumes/65/wr/mm6501a2.htm>; Kyla Hagan-Haynes, Stephanie Pratt, Steven Lerman, Imelda Wong, Angela Baker, David Flower, and Vanessa Riethmeister, “U.S. research needs related to fatigue, sleep, and working hours among oil and gas extraction workers,” *American Journal of Industrial Medicine*, vol. 65, no. 11, Nov 14, 2021, pp. 840–856, <https://doi.org/10.1002/ajim.23310>; Eric J. Esswein, John Snawder, Bradley King, Michael Breitenstein, Marissa Alexander-Scott, and Max Kiefer, “Evaluation of some potential chemical exposure risks during flowback operations in unconventional oil and gas extraction: preliminary results,” *Journal of Occupational and Environmental Hygiene*, vol. 11, no. 10, August 2014, pp. D174–D184, <https://doi.org/10.1080/15459624.2014.933960>; Eric J. Esswein, Bradley King, Mwangi Ndonga, and Evgeny Andronov, “Respirable crystalline silica is a confirmed occupational exposure risk during hydraulic fracturing: What do we know about controls?,” Proceedings from the Silica in the Oilfield Conference, *Journal of Occupational and Environmental Hygiene*, vol. 16, no. 10, October 2019, pp. 669–674, <https://doi.org/10.1080/15459624.2019.1652757>; and David J. Blackley, Kyla D. Retzer, Warren G. Hubler, Ryan D. Hill, and A. Scott Laney, “Injury rates on new and old technology oil and gas rigs operated by the largest United States onshore drilling contractor,” *American Journal of Industrial Medicine*, vol. 57, no. 10, October 2014, pp. 1188–1192, <https://doi.org/10.1002/ajim.22356>.

⁵ Different industry codes—in this case North American Industry Classification (NAICS) codes and National Health Interview Survey (NHIS) detailed industry codes—have previously been used to identify and characterize U.S. OGE workers. The article also illustrates an important point for researchers—even relatively large population-based public health surveys, such as NHIS, may be statistically underpowered to address research questions pertaining to OGE workers, even when data are aggregated over 11 years. See Tashina Robinson, Aaron Sussell, Kristin Yeoman, Kyla Retzer, and Gerald Poplin, “Health conditions in retired manual labor miners and oil and gas extraction workers: National Health Interview Survey, 2007–2017,” *American Journal of Industrial Medicine*, vol. 64, no. 2, February 2021, pp. 118–126, <https://doi.org/10.1002/ajim.23195>.

⁶ The occupations that are in greatest demand during oil and gas booms require vocational and technical training, in addition to a high school diploma. See Isha Rajbhandari, Alessandra Faggian, and Mark D. Partridge “Oil and gas boomtowns and occupations: what types of jobs are created?,” *Energy Economics*, vol. 115, November 2022, <https://doi.org/10.1016/j.eneco.2022.106321>. The words workers use to describe their jobs may differ from standardized industrial and occupational codes. Formal analysis of workers’ language may facilitate communication, translation, and automated work variable coding. See Philip Harber, Lori Crawford, Katie Liu, and Levanto Schachter, “Working words: real-life lexicon of North American workers,” *Journal of Occupational and Environmental Medicine*, vol. 47, no. 8, August 2005, pp. 859–864, <https://doi.org/10.1097/01.jom.0000169095.16779.66>.

⁷ The U.S. Office of Management and Budget (OMB) in the Executive Office of the President produces the North American Industry Classification System Manual for the United States. The Economic Classification Policy Committee of the United States acts on behalf of OMB, in cooperation with Statistics Canada and Mexico’s *Instituto Nacional de Estadística y Geografía*, to create and maintain a common industry classification system among North American countries. For a general overview of NAICS and the Standard Industrial Classification system, see “North

American Industry Classification System (NAICS) at BLS” (U.S. Bureau of Labor Statistics, last modified July 25, 2023), <https://www.bls.gov/bls/naics.htm>. For current NAICS classifications, see “North American Industry Classification System” (U.S. Census Bureau, last modified April 3, 2025), <https://www.census.gov/naics/>. As with most NAICS codes, Oil and gas extraction ([NAICS 211](#)), Crude petroleum extraction ([NAICS 211120](#)), Natural gas extraction ([NAICS 211130](#)), Support activities for mining ([NAICS 213](#)), Drilling oil and gas wells, ([NAICS 213111](#)), and Support activities for oil and gas operations ([NAICS 213112](#)) all have associated pages on the NAICS website.

⁸ For more details on the occupation and industry classifications, see “Industry and occupation code lists and crosswalks” (U.S. Census Bureau, last modified September 11, 2024), <https://www.census.gov/topics/employment/industry-occupation/guidance/code-lists.html>. Additionally, for the relationship between NAICS and Census industry codes, see “Occupation and industry data collection and use” (U.S. Centers for Disease Control and Prevention), <https://www.cdc.gov/niosh/occupation-industry-data/about-data/coding/classification-systems.html>.

⁹ Retzer, Hill, and Pratt, “Motor vehicle fatalities among oil and gas extraction workers.”

¹⁰ For more information on the National Occupational Research Agenda (NORA) Oil and Gas Extraction Sector Council, see “NORA Oil and Gas Extraction Council” (Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, last modified April 28, 2023), <https://www.cdc.gov/nora/councils/oilgas/default.html>. For more information on the Oil and Gas Extraction Program, see “Oil and Gas Extraction Program” (Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health), <https://www.cdc.gov/niosh/research-programs/portfolio/oil-gas-extraction.html>.

¹¹ The National Council for Compensation Insurance (NCCI) industry classification system is described in National Council for Compensation Insurance, *Basic Manual for Workers Compensation and Employers Liability Insurance* (National Council for Compensation Insurance, 2023), <https://www.ncci.com/ServicesTools/Pages/BM2001.aspx> Some states use alternative industry classification systems. One example is Washington state: see “Chapter 296-17A: WAC classifications for Washington workers' compensation insurance” in *Washington Administrative Code* (Washington State Legislature, 2024), <https://apps.leg.wa.gov/WAC/default.aspx?cite=296-17A&full=true&pdf=true>. The use of these industry classifications for setting prevention priorities is illustrated in Naomi J. Anderson, David K. Bonauto and Darrin Adams, “Prioritizing industries for occupational injury and illness prevention and research, Washington State workers' compensation claims data, 2002–2010,” Technical Report Number 64-1-2013, (Washington State Department of Labor and Industries, 2013), <https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=90b8209c5c5917217e334ae60a19b35e07d4fef5>.

¹² See states that use NCCI class codes in “NCCI fact sheet,” (National Council for Compensation Insurance, last modified April 15, 2025), https://www.ncci.com/Articles/Pages/AU_NCCIFactSheet.pdf.

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¹⁴ John M. Abowd, Bryce E. Stephens, Lars Vilhuber, Fredrik Andersson, Kevin L. McKinney, Marc Roemer, and Simon Woodcock, “The LEHD infrastructure files and the creation of the Quarterly Workforce Indicators,” Technical Paper No. TP-2006-01 (U.S. Census Bureau, LEHD Program, December 2005), https://lehd.ces.census.gov/doc/technical_paper/tp-2006-01.pdf.

¹⁵ These median pay figures exclude benefits, bonuses, and overtime pay.

¹⁶ See Retzer, Hill, and Pratt, “Motor vehicle fatalities among oil and gas extraction workers”; Mason, Retzer, Hill, and Lincoln, “Occupational Fatalities Resulting from Falls in the Oil and Gas Extraction Industry”; Mason, Retzer, Hill, and Lincoln, “Occupational fatalities during the oil and gas boom”; and Barbara M. Alexander, Alejandra Ramirez-Cardenas, Steven J. Wurzelbacher, Alysha R. Meyers, and Steven J. Naber, “Oil and gas extraction industry workers' compensation claims and proposed safety interventions,” *Journal of Occupational and Environmental Medicine*, vol. 68, no. 8, August 2024, pp. 635–647, <https://doi.org/10.1097/jom.0000000000003124>.

¹⁷ See Wingate, Scott, Pratt, King, Esswein, Ramirez-Cardenas, Snawder and Hagan-Haynes, “Self-reported exposure to hazards and mitigation strategies among oil and gas extraction workers in three U.S. states;” and Kyla Hagan-Haynes, Alejandra Ramirez-Cardenas, Kaitlin C. Wingate, Stephanie Pratt, Sophie Ridl, Emily Schmick, John Snawder, Elizabeth Dalsey, and Christa Hale “On the road again: a cross-sectional survey examining work schedules, commuting time, and driving-related outcomes among U.S. oil and gas extraction workers.” *American Journal of Industrial Medicine*, vol. 65, no. 9, September 2022, pp. 749–761, <https://doi.org/10.1002/ajim.23405>.

¹⁸ Hagan-Haynes, Ramirez-Cardenas, Wingate, Pratt, Ridl, Schmick, Snawder, Dalsey, and Hale “On the road again.”

¹⁹ Abowd, Stephens, Vilhuber, Andersson, McKinney, Roemer, and Woodcock, “The LEHD infrastructure files and the creation of the Quarterly Workforce Indicators.”

²⁰ Recent American Community Survey (ACS) data are most conveniently downloaded from a U.S. Census Bureau website entitled “Select a dataset and vintage,” <https://data.census.gov/mdat/>. Total employment can be calculated as the sum of those at work and those not at work but with a job in Census industry codes 0370 and 0470 (equivalent to NAICS 211 and 213).

Data from County Business Patterns can be extracted from the U.S. Census Bureau table search page, <https://data.census.gov/cedsci/table>.

Consumer Expenditure Survey (CES) employment data can be downloaded from the Bureau of Labor Statistics (BLS) website, <https://www.bls.gov/ces/data/>.

Data were extracted from the NIOSH Employed Labor Force query system (ELF), https://wwwn.cdc.gov/Wisards/cps/cps_estimates.aspx. This system is designed to facilitate the use of CPS data on employed populations by industry and occupation for use in public health. Total jobs can be calculated by summing the number of workers with a primary job and the number of workers with a secondary job and subtracting the number of workers with both a primary and secondary job in Census industry codes 0370 and 0470.

Employment by NAICS industry code and year is available on the “Tables” webpage of the BLS Office of Productivity and Technology under “Hours worked and employment measures,” <https://www.bls.gov/productivity/tables/>.

The Quarterly Census of Employment and Wages (QCEW) data used in this article were accessed on June 20, 2023 using a computer program provided by BLS to directly download comma separated values (CSV) files from the BLS website. Both the program and the files are available through QCEW Open Data Access, <https://www.bls.gov/cew/additional-resources/open-data/>. Recent QCEW data can also be downloaded from <https://www.bls.gov/cew/downloadable-data-files.htm>. Quarterly Workforce Indicators (QWI) is based on the same unemployment insurance data that are the foundation for the QCEW.

Nonemployer statistics data can be extracted from U.S. Census Bureau table search page, <https://data.census.gov/cedsci/table>. Select “Nonemployer statistics” under “Economic surveys.”

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²³ Katherine G. Abraham, Brad J. Hershbein, Susan N. Houseman, and Beth C. Truesdale, “The independent contractor workforce: new evidence on its size and composition and ways to improve its measurement in household surveys” (Upjohn Institute, Working Paper 23-380, February 2023), <https://doi.org/10.17848/wp23-380>.

²⁴ See the discussion of variation in respondent interpretation of survey questions about self-employment and misclassification of independent contractors as employees in *Measuring Alternative Work Arrangements for Research and Policy* (Washington, DC; The National Academies Press, 2020), pp. 5–6, <https://doi.org/10.17226/25822>.

²⁵ Specialist employment (NAICS 213111 and 213112) ranged between 78 and 95 percent of lead establishment employment (NAICS 211) in 1990–1994 and between 180 and 231 percent of lead establishment employment in 2018–2022. These figures were calculated from QCEW data downloaded on May 19, 2025 from the BLS website at <https://www.bls.gov/cew/downloadable-data-files.htm>.

²⁶ “Oil prices and outlook” (U.S. Energy Information Administration, last updated August 16, 2023), <https://www.eia.gov/energyexplained/oil-and-petroleum-products/prices-and-outlook.php>.

²⁷ See Richie Ruchuan Ma, Tao Xiong, and Yukun Bao, “The Russia–Saudi Arabia oil price war during the COVID-19 pandemic,” *Energy Economics*, vol. 102, October 2021, <https://doi.org/10.1016/j.eneco.2021.105517>; Kevin M. Camp, David Mead, Stephen B. Reed, Christopher Sitter, and Derek Wasilewski. “From the barrel to the pump: the impact of the COVID-19 pandemic on prices for petroleum products,” *Monthly Labor Review*, October 2020, <https://www.bls.gov/opub/mlr/2020/article/from-the-barrel-to-the-pump.htm>.

²⁸ See Pickenpaugh and Adder, “Shale gas production and labor market trends in the U.S. Marcellus–Utica region over the last decade”; Camp, Mead, Reed, Sitter, and Wasilewski, “From the barrel to the pump”; and Jennifer Cruz, Peter W. Smith, and Sara Stanley, “The Marcellus Shale gas boom in Pennsylvania: employment and wage trends,” *Monthly Labor Review*, February 2014, <https://www.bls.gov/opub/mlr/2014/article/the-marcellus-shale-gas-boom-in-pennsylvania.htm>.

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